NASA TECH BRIEF
Marshall Space Flight Center

Composite Mobile System For Holographic Nondestructive Testing

The most promising application of holography at present appears to be in the area of nondestructive testing. This subject has been widely discussed by workers in the field of holography and is fast becoming a field in its own right. There are basically three main types of nondestructive testing, namely, real time analysis, the double exposure method, and the time averaging process.

In real-time holography, a single exposure is made with the object in equilibrium. After development, the holographic plate is replaced in the recording position and is illuminated with the reference beam. Any deformation of the object slightly changes the phase of the reflected light, and destructive interference takes place for points whose phase is changed by an odd multiple of 180 degrees, i.e., a path length change equal to one-half wavelength of the laser light. This destructive interference is evidenced by dark bands or fringes which appear across the virtual image. The frequency and the position of these fringes can be analyzed to determine the magnitude and the direction of the deformation. As long as the object is not displaced more than a few wavelengths of light, any number of different deformations may be analyzed and photographically recorded. Macroscopic movement of any system component, however, destroys the real-time fringes.

Interference fringes are also observed with double-exposure holography, but their origin is different. In the double-exposure method, an exposure is made with the object in equilibrium as in the real-time method, but the object is stressed, and a second exposure is made before the plate is removed. The hologram is then developed and illuminated by the reference beam. Two virtual-images are formed because two exposures were made. Any deformation in the object between exposures causes the phases of the reflected light to differ, which results in the same type of interference fringes mentioned above.

Time-average holography is most useful in the analysis of periodic deformations of an object caused by vibration. With this technique, two positions of the object are recorded because a periodically vibrating object is located at or near the two peaks of the vibration the majority of the time. Upon reconstruction, interference between the wave fronts from the two virtual-images again causes fringe formation. The analysis of the fringes yields information on the shape and the amplitude of the vibrating areas.

In all cases the quantitive information is obtained by the analysis of the interference fringes which occur in the vicinity of the reconstructed image of the object under study. The major difference between these three main types of nondestructive testing lies in the amplitude or velocity of the motion of the test object, in that this deformation results in path length change of the illuminating object beam. Therefore, the user must first determine which method should be used and then set about to arrange a particular set up for his particular test. If he decides to investigate his object using a different method of nondestructive testing, he must set up a completely different arrangement, dependent on his first choice of component placement.

It is the general purpose of the present innovation to provide a single system for nondestructive testing which will have the capability of being mobile (used outside of the laboratory) and the versatility to allow any one of the three main nondestructive test methods to be used. It thereby provides the user with a system flexible enough to test objects ranging from large amplitude displacement and/or velocities down to extremely small displacements and/or velocities by making only a few minor adjustments in the component arrangements.

(continued overleaf)

Notes:

1. Information concerning this innovation may be of interest to optical companies or any company using nondestructive test methods.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B72-10351

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Marshall Space Flight Center
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